# International Conference on Multiscale Methods and Partial Differential Equations, August 26-27, 2005, IPAM

## Final Report for DOE Grant DE-FG02-05ER25668

The International Conference on Multiscale Methods and Partial Differential Equations (ICMMPDE for short) was held at IPAM, UCLA on August 26-27, 2005. The conference brought together researchers, students and practitioners with interest in the theoretical, computational and practical aspects of multiscale problems and related partial differential equations. The conference provided a forum to exchange and stimulate new ideas from different disciplines, and to formulate new challenging multiscale problems that will have impact in applications.

Professors Weinan E (Computational and Applied Math, Princeton) and Thomas Y. Hou (Applied and Computational Math, CalTech) were the co-chairs of the conference. The other members of the organizing committee were Profs. Russel Caflisch (UCLA), Tony Chan (UCLA), Stanley Osher (UCLA), Hongkai Zhao (UCI) and Dr. Richard Tsai (Austin). A total of 69 participants attended the workshop. We mailed out a large number of conference posters to many universities in the US and around the world. Moreover, we announced in the conference website that special fund was available to support young participants as well as women and under-represented minority participants to attend ICMMPDE. In addition, we waived registration fees to student participants and waived registration fees for students from southern California. More importantly, we have provided financial support of order $600 to support about 6 young participants (consult Appendix I below).

**Scientific program**. We had an excellent scientific program for this two-day conference. There were 11 distingished speakers, who were listed below:

Luis Caffarelli (University of Texas, Austin)
Tony Chan (UCLA)
Ingrid Daubechies (Princeton University)
Irene Gamba (University of Texas, Austin)
Roland Glowinski (University of Houston)
John Nash, Jr. (Princeton University)
Jean-Claude Nedelec (Ecole Polytechnique, Palaiseau France/CMAP)
Stanley Osher (UCLA), George Papanicolaou (Stanford University)
Takis Souganidis (University of Texas, Austin)
Eitan Tadmor (University of Maryland)

A very unique feature of ICMMPDE was to promote cross disciplinary interactions among researchers and practitioners. This includes cross interaction between theory and numerics, numerics and applications, theory and applications. The conference covered a wide variety of topics, ranging from imaging processing, to random media, electromagnetic scattering, superfast Fourier transforms, and homogenization for nonlinear PDEs. ICMMPDE brought together leading researchers, students and practitioners to address the new theoretical and computational developments in multiscale problems arising from various applications. There were several interesting talks on imaging process. In particular, Prof. Osher's lecture was

on inverse scale space for image restoration. He reviewed some new results obtained with his collaborators in image processing and general inverse problems. Then he discussed the state-of-the-art efficient image restoration methods result from easy to explain nonlinear optimization considerations. His talk generated a lot of interest and stimulated a lot of discussions during and after his lecture. The lecture by Eitan Tadmor was on a related area regarding the edge detection, hierarchical decompositions and velocity averaging. He discussed three problems which are dominated by the presence of different scales. The first problem deals with edge detection in noisy spectral data using separation of scales. The second problem originates with image processing in which he presented a novel representation of texture which is decomposed into hierarchical scales of edges. He concluded the lecture with a discussion on velocity averaging of kinetic to macroscopic scales.

Prof. Ingrid Daubechies from Princeton University gave a very interesting talk on Superfast Fourier transforms. In her lecture, she said that although the FFT is "Fast" (as its name indicates), its O(NlogN) complexity can still be too slow for truly large, three-dimensional data sets. She presented some new and exciting results on how to further reduce the complexity of the Fourier transforms to be independent of $N$ when the function to be transformed can be well approximated by a sparse Fourier expansion. Another interesting lecture was given by Prof. George Papanicolaou from Stanford University. He spoke on his recent work on adaptive imaging in random media. He first reviewed the basic resolution theory of array imaging with Kirchhoff migration (seismic, sonar, ultrasonic) and he then introduced coherent interferometric imaging, which is the back propagation of local space-time correlations of the array data. He further explained why interferometry works well in random media and presented a resolution theory for this kind of imaging. At the end, he illustrated the theory and its limitations with the results of extensive numerical simulations, including the adaptive estimation of the decoherence parameters.

A highlight of the conference was the lecture by Prof. John Nash, who spoke on "A New Method for Studying the Coalescence Process and the Natural Realization of Cooperation in Cooperative Games". Prof. Nash's lecture attracted a very large audience. Judging from the very high quality of the scientific program and the scientific interaction that it has generated among participants, the conference was apparently a big success. It provided an excellent overview of the state-of-the-art methodology in multiscale analysis and computation and its relation to the partial differential equations, and identified some remaining challenges in the field. Many people told us that we have done a great job in organizing this conference and they have benefited from the conference and from the interaction with other participants.

**Banquet**. A highlight of the ICMMPDE conference was the conference banquet on Friday evening (8/26/05). The banquet was held at IPAM. Prof. Mark Green, director of IPAM, made the opening speech to welcome everyone to this IPAM conference. This conference also coincided with the 60th birthday of Prof. Bjorn Engquist. Prof. Engquist is an outstanding applied mathematician. He and Prof. Stanley Osher together built up a first rate applied mathematics program at UCLA and trained many outstanding students. A number of speakers, including Prof. Stanley Osher, Tony Chan, Eitan Tadmor, as well as some of Engquist's former students, spoke about Engquist's scientific contributions.

**Support**. We have received strong administrative support from IPAM in hosting this conference. In particular, we should thank Janice Amar and Lynne Duncan from IPAM and

Sheila Shull from Caltech who made all the organizational work go very smoothly. Additional support was also provided by NSF and ONR. All these contributed to the overall success of the conference.

## Budget

The DOE fund was spent to cover the travel and local expenses for the invited speakers, and to provide support for several young participants and some members of the organizing committee. Below we list the detailed expenses that we spent for the DOE grant for ICMPDE:

I. **Expenses for Invited Speakers**.

Luis Caffarelli: $570.90
Irene Gamba: $1,000
Roland Glowinski: $991.47
Jean Claude Nedelec: $1,500
George Papanicolaou: $607.20
Panagiotis Souganidis: $896.60

II. **Expenses for young participants.**

Thomas Cecil (University of Texas, Austin): $562.88
Chiu Yen Kao (University of Minnesota): $600
Melvin Leok (University of Michigan): $600
Hailiang Liu (Iowa State University): $600
Yi Sun (Princeton University): $595.49

III. **Expenses for organizing committee.**

Thomas Hou (Caltech): $426.20
Richard Tsai (University of Texas at Austin): $1,000

**Total** : $9950.74